DEC 08 2004
PATENT AND TRADEMARK OFFICE

METHOD FOR OBSERVING HIGH-ALTITUDE NEUTRAL AIR AND DEVICE FOR OBSERVING HIGH-ALTITUDE NEUTRAL AIR

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to a method for observing high-altitude neutral air and a device for observing high-altitude neutral air which are usable in space operational business enterprise and space weather forecast business enterprise.

Description of the related art

[0002] ~~As has gotten a lot of attention in the falling of the Mir space station at March, 2001, if a large-scaled space structure is plunged into atmosphere and reached to earth, it is concerned that the space structure affects on our social life to some degree. In this point of view, data~~ Data concerning high-altitude neutral air ~~are~~is very important because the ~~orbit~~orbital altitude of a space satellite may ~~be decreased~~decay due to the atmosphere drag in the high-altitude neutral air and the ~~plunge timing~~reentry of the space satellite into the atmosphere can be predicted from the high-altitude neutral air data.

[0003] In a conventional observation for the high-altitude neutral air, an observing instrument is mounted on a space satellite, which is disposed in the high-altitude neutral air. As a result, since the observing instrument is positioned in a given area of the high-altitude neutral air, the observation for the high-altitude neutral air is carried out at every area where the observing instrument is positioned.

[0004] Since the observing area is contaminated by positioning the space satellite, with the conventional technique, the high-altitude neutral air can not be observed precisely. Moreover, with the conventional technique, only the data concerning a given area of the high-altitude neutral air by positioning the observing instrument in the given area can be obtained, so the total data concerning the high-altitude neutral air can not be obtained simultaneously.

[0005] The data concerning the high-altitude neutral air can be obtained from the Jacchia model (Standard Jacchia Reference Atmosphere 1977) which is a simulated and modeled distribution of high-altitude neutral air based on the changes in altitude of many previously launched space satellites ~~launched in the~~

~~past~~. Since the predictive accuracy of the Jacchia model is poor, ~~however,~~ it can not be employed in a technical field requiring prompt response and accuracy such as the prediction ~~in atmosphere plunge~~of the reentry of a space satellite ~~and the like~~.

~~SUMMERY~~SUMMARY OF THE INVENTION

[0006] It is an object of the present invention~~, in this point of view,~~ to observe the high-altitude neutral air widely and precisely.

[0007] ~~In order to achieve the above-mentioned objects, this invention relates to a~~A method for observing high-altitude neutral air~~,~~ ~~comprising~~ comprises the steps of:

discharging ion particles so as to be trapped with magnetic field lines of the earth,

colliding the ion particles with high-altitude neutral air to generate high velocity neutral particles through charge exchange, and

~~trapping~~detecting the high velocity neutral particles, ~~to determine~~determining the distance to the high-altitude neutral air from at least one of the ~~discharging~~ discharge positions of the ion particles and the ~~trapping~~ detected positions of the high velocity neutral particles based on the period of time between the discharg~~inge~~ ~~timings~~ of the ion particles and the ~~trapping~~ detection ~~timings~~ of the high velocity neutral particles, thereby~~to determine~~ determining both the direction of the high-altitude neutral air based on the ~~trapping~~ direction of the high velocity neutral particles~~,~~ and ~~to determine~~ the ~~space~~spatial position of the high-altitude neutral air.

[0008] In ~~the present invention, for example,~~an exemplary embodiment, a given ion source is disposed ~~on the orbit of the earth,~~in earth orbit and ~~then,~~ ion particles are then discharged from the ion source so as to be trapped by the magnetic field lines of the earth. When the ion particles ~~are~~ collide~~d~~ with the high-altitude neutral air, high velocity neutral particles are generated through ~~the~~ charge exchange with the ion particles ~~in the high-altitude neutral air~~. The high velocity neutral particles travel inertially without ~~the disturbance of~~being disturbed by the magnetic field lines of the earth, and ~~trapped~~are detected with a ~~given~~ neutral particle analyzer disposed ~~on~~in the orbit ~~of~~around the earth.

[0009] The ~~discharging velocities~~discharge velocity of the ion particles can be predetermined, and the ~~velocities~~velocity of the neutral particles can be measured with the neutral particle analyzer. Moreover, the relative position between the ion source and the neutral particle analyzer can be predetermined, and the discharging angles of the ion particles from the ion source ~~and~~as well as the observing angle of the neutral particle analyzer can also be predetermined. Therefore, if the ~~periods~~period of time between the ~~discharging timings~~discharge time ~~of~~ the ion particles and the ~~trapping timings~~detection ~~time~~ of the neutral particles ~~are~~is measured, at least one of the distances between~~, first,~~ the high-altitude neutral air and the ion source and~~, between second, between~~ the high-altitude neutral air and the neutral particle analyzer can be determined.

[0010] Moreover, since the neutral particles can be ~~trapped~~detected with the neutral particle analyzer, the direction of the high-altitude neutral air can be determined from the ~~trapping~~detected directions of the neutral particles.

[0011] ~~In addition, in the present invention, since~~Furthermore, based upon the ~~distance for the high-altitude neutral air~~distances and the direction of the high-altitude neutral air ~~are measured as mentioned~~measured above, the ~~space~~spatial position of the high-altitude neutral air can be determined ~~therefrom~~.

[0012] Herein, the wording "high-altitude neutral air" means an atmosphere within an altitude range of about 100km-1000km.

[0013] Also, the wording "charge exchange" means a reaction where an ion particle "A" is collided with an ion particle "B", causing the charge transfer of the ion particle "A" to the ion particle "B" and thus, generating a high velocity neutral particle "A" and a high velocity neutral particle "B" ($A^*+B \rightarrow A+B^*$).

[0014] ~~In the present invention~~Furthermore, ~~since the~~ high velocity neutral particles ~~can~~ may be generated from the charge exchange with the ion particles in the high-altitude neutral air. By measuring~~, if~~ the ~~trapping~~ detection frequency of the neutral particles~~, is measured with the neutral particle analyzer,~~ the particle density of the high-altitude neutral density ~~can~~may be determined.

[0015] If the ion particles are made of the same particles as the neutral particles, the ~~energies~~ energy of the ion particles and the ~~energies~~ energy of the neutral particles before and after their collision ~~can~~ may be conserved ~~before and after the collision between the ion particles and the neutral particles~~. Therefore,

the kinetic ~~energies~~energy of the neutral particles ~~are~~is equal to the kinetic ~~energies~~energy of the ion particles. In contrast, if the ion particles are made of different particles from the neutral particles, the kinetic ~~energies~~energy of the neutral particles ~~are~~is increased ~~and~~or decreased based on the differences in ionization voltage between the ion particles and the neutral particles before and after ~~the~~their collision ~~therebetween~~.

[0016] Since the ~~sorts~~ composition of the ion particles are known, if the ~~increasing and decreasing~~change in kinetic energy of the ion particles ~~are~~ is measured, the ~~sorts~~~~type~~composition of particles in the high-altitude neutral air can be determined ~~through the collision~~, and thus, the composition of the high-altitude neutral air can be determined.

[0017] It is desired that the ion particles are ~~made~~ comprised of particles which rarely exist on the high and low orbits of the earth. In this case, the ion particles can be recognized clearly against other particles in the space. Concretely, the ion particles may be made of krypton particles or xenon particles.

[0018] The ion particles may be discharged in pulse or modulation. In this case, the discharging timings of the ion particles and the trapping timings of the high velocity neutral particles can be recognized clearly, and the distance for the high-altitude neutral air can be measured easily and precisely.

[0019] ~~In this way, according to the present invention, the space~~The spatial position, the density and the composition of the high-altitude neutral air ~~can~~ may be determined precisely. By controlling ~~If~~ the ~~discharging angles~~discharge angle of the ion particles from the ion source and the observing angle of the neutral particle analyzer ~~are~~is ~~controlled appropriately~~, the density and the composition of the high-altitude neutral air can be widely determined in a short period of time.

BRIEF DESCRIPTION OF THE DRAWINGS

For better understanding of the present invention, reference is made to the attached drawings, wherein

Fig. 1 is an explanatory view relating to a method for observing high-altitude neutral air according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] This invention will be described in detail with reference to the

accompanying drawings.

Fig. 1 is an ~~explanatory view relating to a~~exemplary method for observing high-altitude neutral air according to the present invention.

In Fig. 1, an ion cluster source is disposed as an ion source on the orbit above the equator of the earth, and a neutral particle analyzer is disposed in the rear side of the ion cluster source. Ion particles are discharged from the ion cluster source, and trapped with the magnetic field lines generated from the axis of the earth. In this case, the ion particles are rotated along the magnetic field lines, which is defined as "Larmor motion", and moved north and south. If a given condition is satisfied, the mirror confining mechanism is generated, so that the ion particles are moved repeatedly north and south.

[0021] ~~In this case, the ion~~Ion particles ~~are~~ collided with inner particles in the high-altitude neutral air (not shown) at the black points in Fig. 1, causing the charge transfer of the ion particles to the inner particles and thus, generating neutral particles in the directions designated by the arrows. The neutral particles travel inertially at their respective high velocities without the disturbance of the magnetic field lines, and are ~~trapped and~~ detected with the neutral particle analyzer.

[0022] The ~~discharging velocities~~discharge velocity of the ion particles can be predetermined, and the ~~velocities~~velocity of the neutral particles can be measured with the neutral particle analyzer. ~~On the other hand~~Furthermore, the relative position between the ion cluster source and the neutral particle analyzer can be predetermined. In addition, the ~~discharging angles~~discharge angle of the ion particles from the ion cluster source can be predetermined and the observing angle of the neutral particle analyzer can be predetermined. Therefore, if the ~~periods~~period of time between the discharging ~~timings~~ of the ion particles and the ~~trapping timings~~detection of the neutral particles ~~are~~is measured, at least one of the distances between either the high-altitude neutral air and the ion cluster ~~source and~~source, ~~or~~and between the high-altitude neutral air and the neutral particle analyzer can be determined.

[0023] The direction of the high-altitude neutral air can be determined from the ~~trapping directions~~detected direction of the neutral particles ~~with~~using the neutral particle analyzer.

[0024] As mentioned above, it is desired that the ion particles are made of particles which rarely exist on the orbit of the earth such as krypton particles or xenon particles in order to be distinguished from other particles in nature. In order to enhance the easiness and precision of the measurement of the distance for the high-altitude neutral air, the ion particles may be discharged in pulse or modulation.

[0025] If the ~~trapping~~detection frequency of the neutral particles ~~are~~is measured with the neutral particle analyzer, the particle density of the high-altitude neutral air can be determined ~~because the high velocity neutral particles can be generated through the charge exchange with the ion particles in the high-altitude neutral air~~. ~~If Since~~Because the composition of the ion particles is known, by measuring the changes in kinetic energy of the neutral ~~particles are measured,~~particles, the composition of the high-altitude neutral air can be determined ~~because the sorts of the ion particles are known and thus,~~based upon the fact that ~~the~~ changes in kinetic energy of the neutral particles depend on the ~~sorts of~~specific composition of particles in the high-altitude neutral air.

[0026] ~~In this embodiment, since~~Because it is not required that the ion cluster source and the neutral particle analyzer ~~are~~be disposed directly in the high-altitude neutral air, the ~~space~~spatial position, the density and the composition of the high-altitude neutral air can be ~~determined precisely~~precisely determined without ~~the~~ contamination from, for example, ~~of~~ the ion cluster ~~source,~~source and~~–~~ the neutral particle analyzer ~~and the like~~. Moreover, if the ~~discharging angles~~discharge angle of the ion particles from the ion cluster source and the observing angle of the neutral particle analyzer ~~are~~is controlled ~~appropriately~~, the density and the composition of the high-altitude neutral air can be determined widely in a short period of time.

[0027] ~~It may be that the~~The ion cluster source and the neutral particle analyzer ~~can~~may be mounted on a space satellite ~~which is~~ disposed ~~on the orbit of the earth~~in an earth orbit. In this exemplary ~~case,~~embodiment, ~~if~~ the position of the space satellite ~~is adjusted,~~may be adjusted so as to position the ion cluster source and the neutral particle analyzer ~~can be disposed~~ as illustrated in Fig. 1 ~~to observe the high-altitude neutral air~~. The ion cluster source and the neutral particle analyzer ~~can~~may be mounted on the same space satellite or ~~respective~~

different space satellites. In the latter case, since the degree of freedom in disposition of the ion cluster source and the neutral particle analyzer ~~can~~may be increased, the high-altitude neutral air ~~can~~may be observed and measured ~~wider~~more widely.

[0028] Although the present invention was described in detail with reference to the above examples, this invention is not limited to the above disclosure and every kind of variation and modification may be made without departing from the scope of the present invention.

[0029] ~~As mentioned above, according to the present invention~~In summary, since it is not required that the ion source and the neutral particle analyzer are disposed directly in the high-altitude neutral air, the ~~space~~spatial position, the density and the composition of the high-altitude neutral air ~~can~~may be ~~determined precisely.~~precisely determined. Moreover, when the ~~discharging angles~~discharge angle of the ion particles from the ion source and the observing angle of the neutral particle analyzer are ~~controlled appropriately,~~appropriately controlled, the density and the composition of the high-altitude neutral air ~~can~~may be determined widely in a short period of time.